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TEST OF A MECHANICAL FILTER

INSTALLED BY THE

NEW YORK FILTER MANUFACTURING COMPANY,

OF NEW YORK,

FOR THE

East Providence Water Company,

EAST PROVIDENCE, R. I.

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REPORTS BY

PROFESSOR JOHN H. APPLETON, GARDNER T. SWARTS, M. D.
AND EDMUND B. WESTON, CONSULTING ENGINEER.

water filter

The Providence Press:
SNOW & FARNHAM, PRINTERS,
15 Custom House Street.
1899

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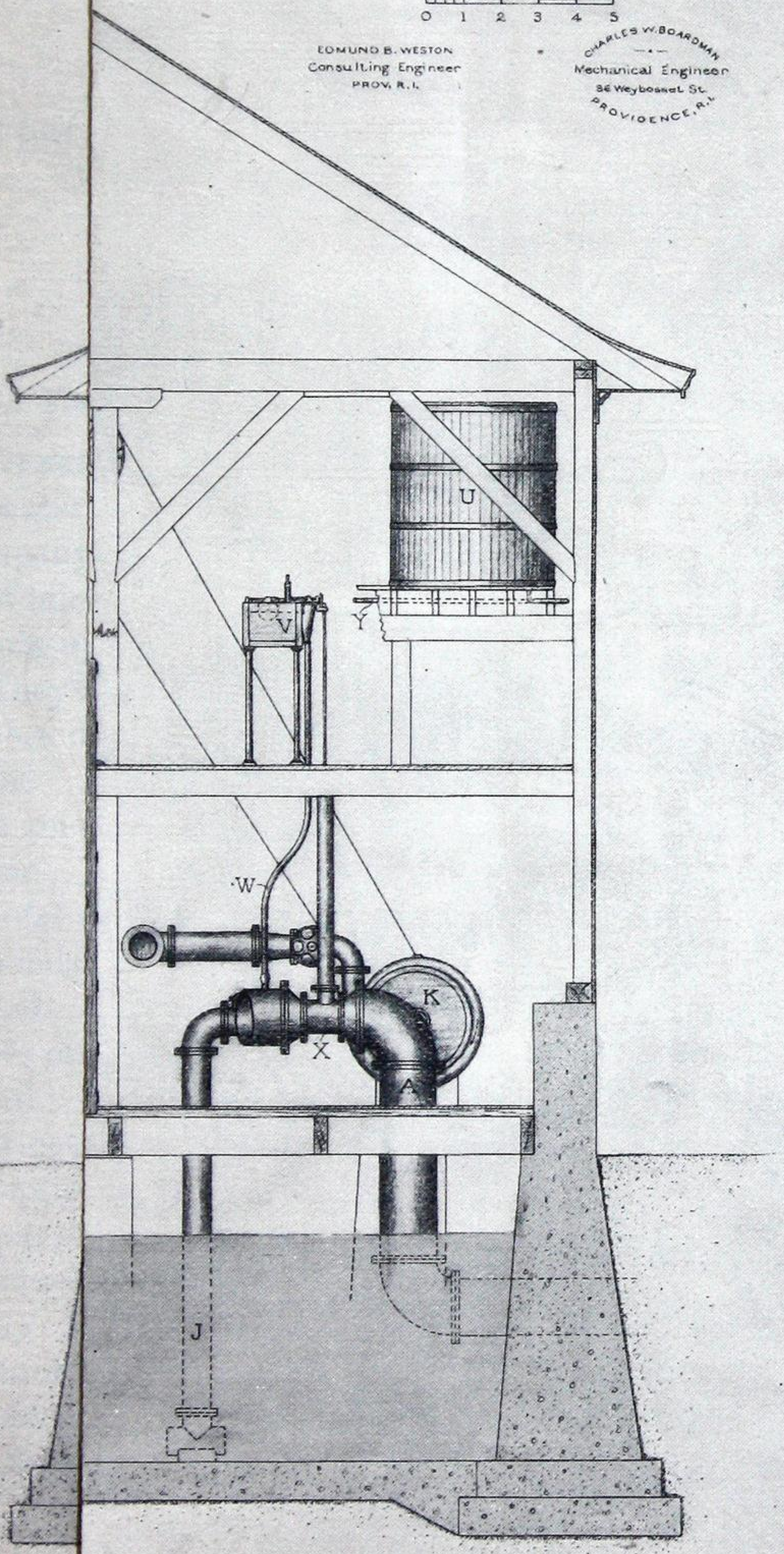
New York Filter Mfg. Co.
Five Hundred Thousand gallon
Jewell Gravity Filter Plant.
of the
East Providence Water Co.

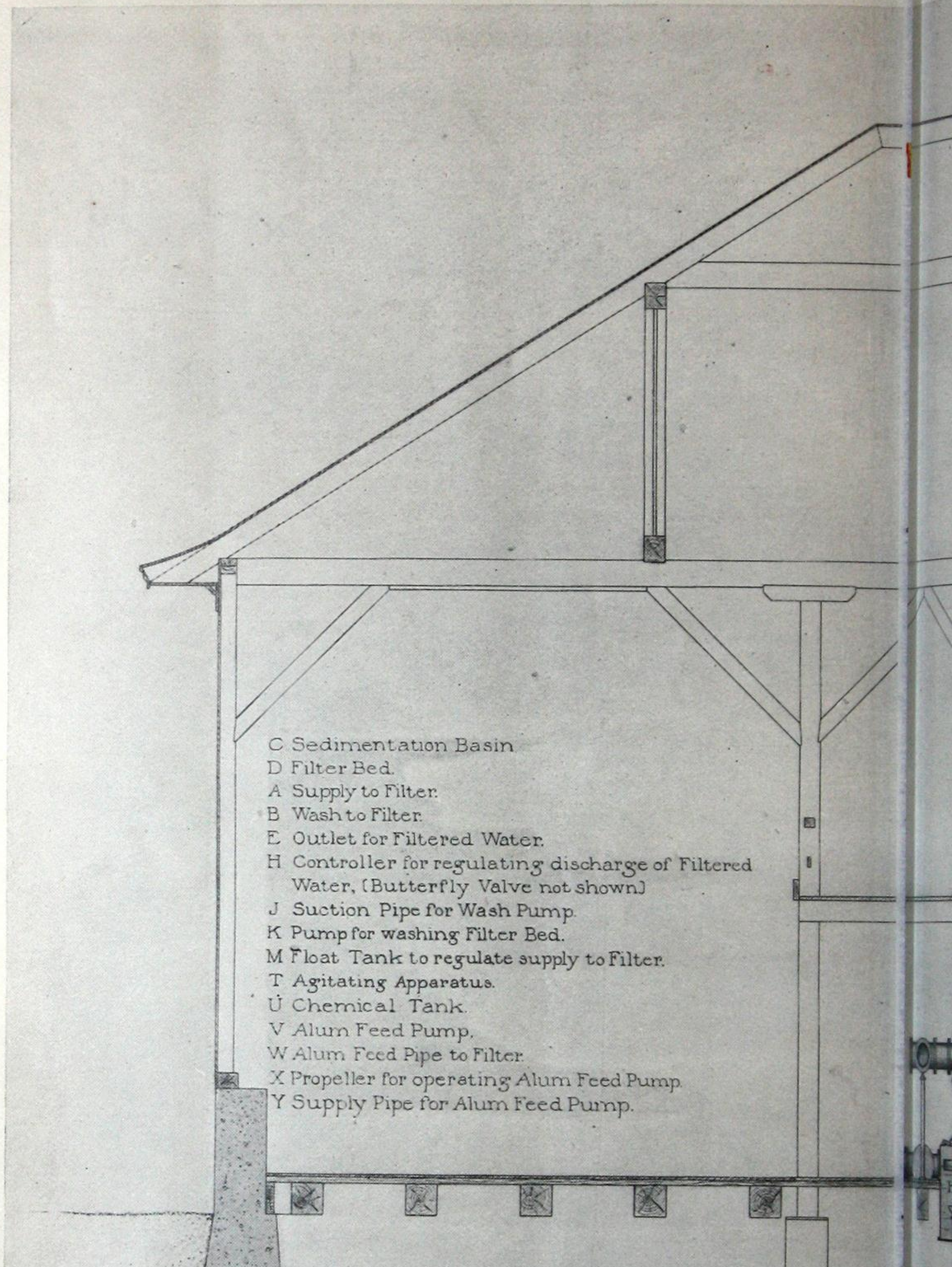
SECTIONAL ELEVATION.

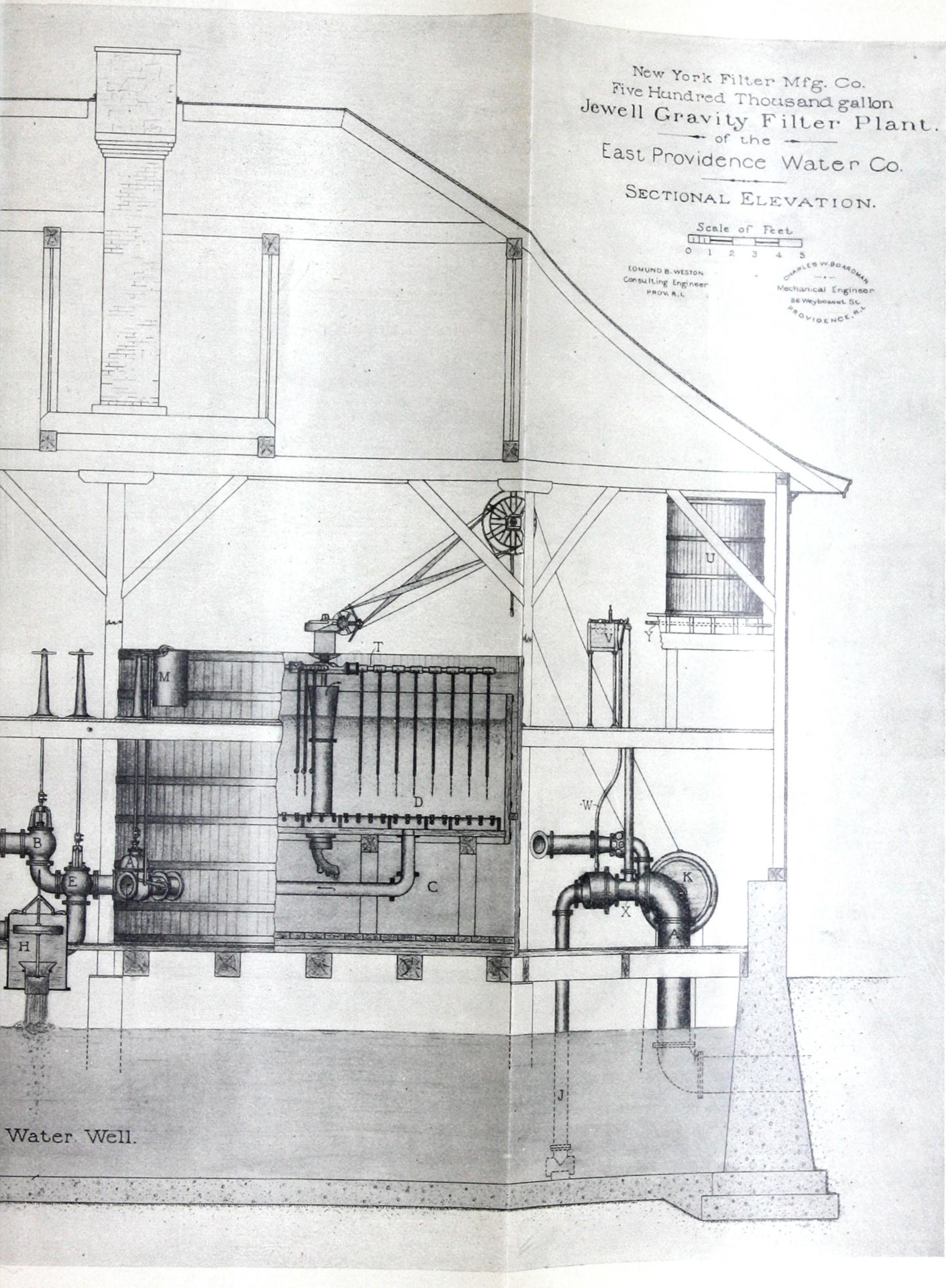
Scale of Feet
0 1 2 3 4 5

EDMUND B. WESTON
Consulting Engineer
PROV. R.I.

CHARLES W. BOARDMAN
Mechanical Engineer
36 Weybosset St.
PROVIDENCE, R.I.




C Sedimentation Basin.
D Filter Bed.
A Supply to Filter.
B Wash to Filter.
E Outlet for Filtered Water.
H Controller for regulating discharge of Filtered Water, (Butterfly Valve not shown)
J Suction Pipe for Wash Pump.
K Pump for washing Filter Bed.
M Float Tank to regulate supply to Filter.
T Agitating Apparatus.
U Chemical Tank.
V Alum Feed Pump.
W Alum Feed Pipe to Filter.
X Propeller for operating Alum Feed Pump.
Y Supply Pipe for Alum Feed Pump.
ered W



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Mechanical Engineer
36 Weybosset St.
PROVIDENCE, R.I.

TEST OF THE MECHANICAL FILTER OF THE EAST PROVIDENCE WATER COMPANY.

REPORT UPON THE CHEMICAL EXAMINATIONS OF SAMPLES OF WATER BY PROFESSOR JOHN HOWARD APPLETON OF BROWN UNIVERSITY.

PROVIDENCE, R. I., July 7, 1899.

New York Filter Manufacturing Company.

GENTLEMEN: — I have made chemical examinations of samples of water (received from you) with results submitted in the accompanying table.

While these results are easily understood, I make a few comments upon them.

They show that your filtration of East Providence water accomplishes decided chemical improvement and in several ways.

1st. You have, in almost all cases, removed a distinctly weighable amount of the total materials dissolved or suspended in the water. This appears by a comparison in the table of the amounts of total solids in the effluents with the amounts of the same group of solids in the raw water.

2nd. You have, in almost all cases, removed a portion of the ferric oxide (oxide of iron).

3rd. With but one exception your filtration has accomplished a reduction of the aluminic oxide (alumina), that is, with but one exception, the alumina in the effluent is less than in the raw water. (It is proper to add that in my work the alumina was determined by standard analytical methods, — not by the logwood test.) I am informed that in your process of purification a certain amount of sulphate of alumina is introduced into the raw water before that water is filtered, — in the East Providence operations the amounts being as follows:

Mch. 9 to Mch. 11,	inclusive,	.75	grain	sulph.	alumina	per	gallon.
Mch. 27 to Mch. 30,	"	.60	"	"	"	"	"
Mch. 31 to Apr. 29,	"	1.00	"	"	"	"	"
May 1 to May 6,	"	.75	"	"	"	"	"
May 8 to May 30,	"	1.00	"	"	"	"	"

4th. You have, in case of all the samples that I have tested, removed a considerable portion (generally more than 50%) of that kind of animal or vegetable matter which yields albuminoid ammonia. Although the absolute amount of such matter present in good drinking water is always small, its relative reduction is very desirable.

I may add, with propriety, what I have observed (although another person has tested numerically upon this subject), that you have removed practically all of the floating and coloring matters in the original water, and that during the period of time covered by my tests you have supplied to takers in East Providence a bright, clear water, about as colorless as distilled water. This is highly advantageous.

Yours, etc.,

JOHN HOWARD APPLETON,

Professor of Chemistry in Brown University, Providence, R. I.

TEST OF THE EAST PROVIDENCE MECHANICAL FILTER.

CHEMICAL ANALYSES OF SAMPLES.

BY PROFESSOR JOHN HOWARD APPLETON.

Rate of Filtration, 125,000,000 Gallons per Acre per 24 hours.

The numbers express parts (by weight) in one million parts of water, (by weight).

DATE.	Total Solids.	Total Hardness.	Chlorine.	Ferric Oxide.	Aluminic Oxide.	N. as Free Ammonia.	N. as Albuminoid Ammonia.	N. as Nitrates.	N. as Nitrites.
RAW WATER.									
Mch. 9	36.4	15.0	3.0			0.01	0.16	0.70	Trace
“ 30	36.7	15.0	2.1	0.42	1.23	0.06	0.14	0.60	“
Apr. 6	39.0	16.0	4.8	0.58	0.47	0.04	0.22	0.60	“
“ 13	39.3	14.0	7.0	0.60	0.80	0.10	0.26	0.90	“
“ 20	39.9	17.0	6.4	0.61	1.05	0.05	0.26	0.70	“
“ 27	43.7	18.0	6.2	1.00	0.75	0.02	0.22	0.70	“
May 4	51.5	17.0	6.8	0.98	1.67	0.03	0.28	0.60	“
“ 11	53.1	21.0	6.4	0.91	1.84	0.03	0.38	0.60	0
“ 18	54.9	21.0	6.1	1.01	0.34	0.03	0.34	0.60	Trace
“ 25	49.6	20.0	6.4	1.09	0.76	0.04	0.32	0.60	“
FILTERED WATER.									
Mch. 9	32.2	17.0	3.0			0.03	0.07	0.60	Trace
“ 30	30.7	18.0	4.0	0.18	0.97	0.04	0.10	0.50	“
Apr. 6	38.9	22.0	4.8	0.61	0.44	0.04	0.10	0.60	“
“ 13	40.4	19.0	6.0	0.45	0.55	0.05	0.11	0.70	“
“ 20	37.4	22.0	6.4	0.28	1.02	0.05	0.10	0.60	“
“ 27	39.6	19.0	6.2	0.19	0.26	0.01	0.07	0.60	“
May 4	49.5	22.0	7.7	0.42	1.08	0.02	0.11	0.60	“
“ 11	47.2	23.0	6.3	0.20	0.55	0.02	0.14	0 40	0
“ 18	49.8	23.0	5.8	0.13	0.47	0.03	0.12	0.50	Trace
“ 25	46.5	24.0	7.2	0.40	0.45	0.02	0.13	0.60	“

TEST OF THE MECHANICAL FILTER OF THE EAST PROVIDENCE WATER COMPANY.

REPORT UPON THE BACTERIOLOGICAL EXAMINATIONS OF SAMPLES OF WATER AND THE COMPARATIVE AMOUNT OF COLOR AND ALKALINITY OF THE SAME,

BY DR. GARDNER T. SWARTS.

PROVIDENCE, R. I., Aug. 10, 1899.

New York Filter Manufacturing Co.

GENTLEMEN : — With a view of determining the bacterial efficiency of the "Jewell" Filter as applied to the waters of the Ten-Mile River, which are used by the East Providence Water Company to supply the town of East Providence, a series of tests were commenced on March 10, 1899.

One sample, each, of waters was taken daily from,

1st. The water from the Ten-Mile River at the Pumping Station in East Providence, before being applied to the filter.

2nd. The water as it came from the filter after being mixed with sulphate of alumina and passed through the filter.

The results are as shown in the accompanying tables.

The sulphate of alumina used contained about 22 per cent of alumina, Al_2O_3, with the exception of from March 10th to 11th inclusive, from June 1st to 7th inclusive, and from June 22nd to 28th inclusive, when an inferior and cheaper grade containing about 17.53 per cent of alumina, Al_2O_3, was used.

It will be noticed in table No. 1, that the bacterial efficiency of the filter was above 99 per cent during the time that the standard grade of sulphate of alumina (containing about 22 per cent of Al_2O_3), was used at the rate of 1 grain per gallon. At other times, when a less quantity of sulphate of alumina was used or an inferior grade (containing about 17.53 per cent of Al_2O_3), the average bacterial efficiency was slightly below 99 per cent. It will also be seen that when an inferior grade of sulphate of alumina was used at the rate of 1.25 grains per gallon (which contained a quantity of Al_2O_3

about equal to what 1 grain of the standard grade contained), that the average bacterial efficiency was above 99 per cent.

The average removal of bacteria during the time that one grain of sulphate of alumina of the standard grade was used (containing about 22 per cent of Al_2O_3), was 99.2 per cent.

The average removal of bacteria during the entire test, when the two grades of sulphate of alumina were used at different periods from 0.60 of a grain to 1.25 grains per gallon, was 98.7 per cent.

COLOR.

It is shown in table No. 2 that the color of the raw water ranged, from March 10th to April 18th, from about .40 to .50, and that during the remainder of the time the average color was about .70. The table also shows that the color of the filtered water was .10, with three exceptions, during the entire time.

The average color removed from the raw water during the process of filtration was about 81 per cent.

ALKALINITY.

As is shown in table No. 3, the filtered water was always alkaline. The alkalinity of both the raw and filtered water gradually increased, to about April 24th, and then continued practically constant. The difference between the alkalinity of the raw and filtered water gradually increased to about April 12th, after which time it remained quite uniform.

The method by which the alkalinity was determined is as follows:

1000 c. c. were used, 500 of which were placed in one porcelain tray and the other 500 c. c. in a second tray.

5 c. c. of solution of methyl orange was added to the solution of each tray.

The testing solution was one of sulphuric acid, each c. c. of which would neutralize one part per million of calcium carbonate when one-half liter of water was used in the test.

The sulphuric acid solution was tested against sodium carbonate and then computed for calcium carbonate.

Very truly yours,

GARDNER T. SWARTS, M. D.

TABLE NO. 1.

TEST OF THE EAST PROVIDENCE MECHANICAL FILTER.

BACTERIOLOGICAL ANALYSES OF SAMPLES.

By Dr. Gardner T. Swarts.

Rate of Filtration, 125,000,000 Gallons per Acre per 24 hours.

Date.	Bacteria per cubic centimetre.		Per cent of Reduction.	Grains of Sulphate of Alumina per Gallon.
	Raw Water.	Filtered Water.		
Mar. 10	954	55	94.24	0.75*
“ 11	480	47	90.21	0.75*
“ 13	768	4	99.48	1
“ 14	595	5.5	99.08	1
“ 15	Sterilized filter-bed.			
“ 16	1299	9	99.31	1
“ 17	1257	7	99.45	1
“ 18	683	4	99.41	1
“ 20	658	7	98.94	0.75
“ 21	1888	26	98.62	0.75
“ 22	1044	31	97.03	0.75
“ 23	1550	37	97.61	0.75
“ 24	3652	51	98.60	0.75
“ 25	1818	16	99.12	0.75
“ 27	512	11	97.85	0.60
“ 28	1142	6	99.47	0.60
“ 29	1025	4	99.61	0.60
“ 30	822	16	98.05	0.60
“ 31	782	1.5	99.82	1
Apr. 1	499	7	98.60	1
“ 3	636	1.5	99.76	1
“ 4	628	2	99.68	1
“ 5	545	4	99.27	1
“ 6	855	3	99.65	1

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* Inferior grade of sulphate of alumina having a relative value of about 80 per cent of the sulphate of alumina used at other times.

TABLE No. 1. — CONTINUED.

DATE.	Bacteria per cubic centimetre.		Per cent of Reduction.	Grains of Sulphate of Alumina per Gallon.
	Raw Water.	Filtered Water.		
Apr. 7	1910	19	99.01	1
" 8	1009	6.5	99.36	1
" 10	1175	6.5	99.45	1
" 11	943	9.3	99.01	1
" 12	1443	9	99.38	1
" 13	336	4.3	98.73	1
" 14	Lost.	4		1
" 15	998	1.6	99.84	1
" 17	765	7.5	99.02	1
" 18	578	6.3	98.91	1
" 19	865	11	98.73	1
" 20	546	3	99.45	1
" 21	699	2	99.97	1
" 22	359	3	99.17	1
" 24	293	3	98.98	1
" 25	697	0.5	99.93	1
" 26	724	11	98.48	1
" 27	422	9	97.87	1
" 28	280	2.5	99.11	1
" 29	370	6	98.38	1
May 1	370	4.5	98.78	0.75
" 2	469	8	98.30	0.75
" 3	403	13	96.77	0.75
" 4	289	61	78.89	0.75
" 5	310	6	98.07	0.75
" 6	316	21	93.35	0.75
" 8	266	9	96.62	1
" 9	976	3	99.69	1
" 10	708	13.5	98.09	1
" 11	150	5	96.66	1
" 12	466	3.5	99.25	1
" 13	305	4	98.69	1
" 15	225	1	99.56	1
" 16	238	0.5	99.79	1
" 17	306	0.5	99.83	1
" 18	473	0	100.00	1

TABLE NO. 1. — CONTINUED.

DATE.		Bacteria per cubic centimetre.		Per cent of Reduction.	Grains of Sulphate of Alumina per Gallon.
		Raw Water.	Filtered Water.		
May	19	210	0.5	99.76	1
"	20	228	1	99.56	1
"	22	238	0.5	99.79	1
"	23	279	1	99.64	1
"	24	228	1	99.56	1
"	25	275	0	100.00	1
"	26	270	0.5	99.81	1
"	27	185	1	99.46	1
"	29	454	4.5	99.01	1
"	30	334	11.5	96.56	1
"	31	458	10	97.82	1
June	1	1478	10	99.32	1*
"	2	387	16	95 87	1*
"	3	411	21	94.89	1*
"	5	548	18	96.72	1*
"	6	434	23	94.70	1*
"	7	587	10	98.30	1*
"	8	331	4	98.79	1
"	9	494	8.5	98.28	1
"	10	341	6.3	98.15	1
"	12	354	0.3	99.92	1
"	13	243	2	99.18	1
"	14	181	0.3	99.83	1
"	15	265	1	99.62	1
"	16	388	0.6	99.85	1
"	17	277	2.5	99 10	1
"	19	Lost.	14		1
"	20	233	8	96.56	1
"	21	291	4.3	98.52	1
"	22	175	2.3	98.69	1.25*
"	23	162	1	99 38	1.25*
"	24	276	2.3	99.17	1.25*
"	26	416	3.3	99.21	1.25*

* Inferior grade of sulphate of alumina having a relative value of about 80 per cent of the sulphate of alumina used at other times.

Table No. 1. — CONCLUDED.

DATE.	Bacteria per cubic centimetre.		Per cent of Reduction.	Grains of Sulphate of Alumina per Gallon.
	Raw Water.	Filtered Water.		
June 27	226	3.6	98.41	1.25*
“ 28	242	1.6	99.34	1.25*
“ 29	2096	4	99.81	1
“ 30	849	4	99.53	1
July 10	2026	5.6	99.72	1
“ 11	321	11	96.57	1
“ 12	398	12	96.98	1
“ 13	262	20	92.37	1
“ 14	402	5	98.76	1
“ 15	148	1.6	98.92	1
“ 17	383	5.6	98.54	1
“ 18	279	0	100.00	1
“ 19	225	1.6	99.29	1
“ 20	86	2.3	97.32	1
“ 21	365	8.3	97.73	1
“ 22	764	3	99.61	1
“ 27	175	0.6	99.66	1
“ 28	159	4.6	97.11	1
“ 29	473	2.3	99.51	1
“ 31	444	1.3	99.71	1
Aug. 1	424	1	99.76	1
“ 2	313	2	99.36	1

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* Inferior grade of sulphate of alumina having a relative value of about 80 per cent of the sulphate of alumina used at other times.

TABLE NO. 2.

Test of the East Providence Mechanical Filter.

COLOR OF SAMPLES.

By Dr. Gardner T. Swarts.

Rate of Filtration, 125,000,000 Gallons per Acre per 24 hours.

The unit of color is practically that color yielded by properly nesslerizing 50 cubic centimetres of water containing one one-hundredth of a milligram of ammonia gas (or its equivalent).

Date.	Raw Water.	Filtered Water.	Grains of Sulphate of Alumina per Gallon.	Date.	Raw Water.	Filtered Water.	Grains of Sulphate of Alumina per Gallon.
Mar. 10	.50	.10	0.75*	Apr. 1	.40	.10	1
" 11	.50	.10	0.75*	" 3	.40	.10	1
" 13	.50	.10	1	" 4	.40	.10	1
" 14	.50	.10	1	" 5	.40	.10	1
" 15	Sterilized filter-bed.			" 6	.40	.10	1
" 16	.50	.10	1	" 7	.40	.10	1
" 17	.50	.10	1	" 8	.40	.10	1
" 18	.50	.10	1	" 10	.50	.10	1
" 20	.50	.10	0.75	" 11	.40	.10	1
" 21	.50	.10	0.75	" 12	.50	.10	1
" 22	.50	.10	0.75	" 13	.50	.10	1
" 23	.50	.10	0.75	" 14	.50	.10	1
" 24	.40	.10	0.75	" 15	.50	.10	1
" 25	.40	.10	0.75	" 17	.50	.10	1
" 27	.40	.10	0.60	" 18	.60	.10	1
" 28	.30	.10	0.60	" 19	.60	.10	1
" 29	.40	.10	0.60	" 20	.60	.10	1
" 30	.40	.10	0.60	" 21	.60	.10	1
" 31	.40	.10	1	" 22	.60	.10	1

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* Inferior grade of sulphate of alumina having a relative value of about 80 per cent of the sulphate of alumina used at other times.

TABLE NO. 2. — CONCLUDED.

DATE.	Raw Water.	Filtered Water.	Grains of Sulphate of Alumina per Gallon.	DATE.	Raw Water.	Filtered Water.	Grains of Sulphate of Alumina per Gallon.
Apr. 24	.60	.10	1	May 13	.90	.10	1
" 25	.60	.10	1	" 15	.80	.10	1
" 26	.60	.10	1	" 16	.90	.10	1
" 27	.70	.10	1	" 17	.80	.10	1
" 28	.70	.10	1	" 18	.80	.10	1
" 29	.60	.10	1	" 19	.70	.10	1
May 1	.60	.10	0.75	" 20	.70	.10	1
" 2	.60	.10	0.75	" 22	.70	.10	1
" 3	.70	.10	0.75	" 23	.60	.10	1
" 4	.70	.10	0.75	" 24	.60	.10	1
" 5	.70	.20	0.75	" 25	.70	.10	1
" 6	.70	.40	0.75	" 26	.60	.10	1
" 8	.70	.10	1	" 27	.60	.10	1
" 9	.70	.10	1	" 29	.60	.10	1
" 10	.70	.20	1	" 30	.60	.10	1
" 11	1.00	.10	1	" 31	.50	.10	1
" 12	1.00	.10	1				

TABLE NO. 3.

Test of the East Providence Mechanical Filter.

ALKALINITY OF SAMPLES.

By Dr. Gardner T. Swarts.

Rate of Filtration, 125,000,000 Gallons per Acre per 24 hours.

The Alkalinity is Expressed as Calcium Carbonate, in Parts Per 1,000,000.

Date.	Raw Water.	Filtered Water.	Grains of Sulphate of Alumina per Gallon.	Date.	Raw Water.	Filtered Water.	Grains of Sulphate of Alumina per Gallon.
Mar. 10	6.4	2.3	0.75*	Apr. 3	9.2	2.7	1
“ 11	6.0	2.7	0.75*	“ 4	9.5	3.2	1
“ 13	5.5	1.7	1	“ 5	8.7	3.2	1
“ 14	7.5	2	1	“ 6	6.5	3	1
“ 15	Sterilized filter-bed.			“ 7	11	3.7	1
“ 16	6.7	1.5	1	“ 8	10	3.2	1
“ 17	7	2	1	“ 10	9	3.7	1
“ 18	6.7	2	1	“ 11	10.5	3.2	1
“ 20	6.2	1.7	0.75	“ 12	11	4	1
“ 21	7.7	1.5	0.75	“ 13	10.2	Lost.	1
“ 22	6.5	2	0.75	“ 14	11.5	4	1
“ 23	5.5	1.7	0.75	“ 15	11.5	5	1
“ 24	6	2	0.75	“ 17	12	4.5	1
“ 25	5.7	1.5	0.60	“ 18	11	4	1
“ 27	7.2	3	0.60	“ 19	11	4.5	1
“ 28	9	4	0.60	“ 20	12	2	1
“ 29	6.5	3	0.60	“ 21	11	4.5	1
“ 30	7.7	3.5	0.60	“ 22	8.5	4.7	1
“ 31	9	2.7	1	“ 24	14	7	1
Apr. 1	8.5	3	1	“ 25	14	7	1

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*Inferior grade of sulphate of alumina having a relative value of about 80 per cent of the sulphate of alumina used at other times.

TABLE NO. 3.—CONCLUDED.

DATE.	Raw Water.	Filtered Water.	Grains of Sulphate of Alumina per Gallon.	DATE.	Raw Water.	Filtered Water.	Grains of Sulphate of Alumina per Gallon.
Apr. 26	14	6	1	May 15	15	5.5	1
“ 27	14	6	1	“ 16	14	5	1
“ 28	14.5	6	1	“ 17	14.5	6.5	1
“ 29	13.5	6	1	“ 18	14.5	6	1
May 1	14.5	7	0.75	“ 19	14	6	1
“ 2	15	8	0.75	“ 20	14.5	6	1
“ 3	13.5	7.5	0.75	“ 22	14	8	1
“ 4	15	7.5	0.75	“ 23	14	6	1
“ 5	14	6.5	0.75	“ 24	14	7	1
“ 6	15.5	6.5	0.75	“ 25	14	7	1
“ 8	15	6.5	1	“ 26	15	6	1
“ 9	14.5	6	1	“ 27	14.5	5	1
“ 10	15	6	1	“ 29	14	5	1
“ 11	14	6	1	“ 30	14	5	1
“ 12	14.5	6.5	1	“ 31	14.5	6	1
“ 13	14.5	5.5	1				

TEST OF THE MECHANICAL FILTER OF THE EAST PROVIDENCE WATER COMPANY.

A BRIEF REPORT OF THE TEST TAKING INTO CONSIDERATION
THE DATA CONTAINED IN THE REPORTS OF
PROF. APPLETON AND DR. SWARTS,
BY EDMUND B. WESTON, C. E.

The following gives results that were obtained during a test of about one hundred and forty-four days of a mechanical filter that has recently been installed, under the direction of the writer, for the East Providence Water Company at East Providence, R. I.

The New York Filter Manufacturing Company of New York furnished the filter, which is of a type known as the Jewell Gravity Filter.

The average daily quantity of water furnished to its consumers by the East Providence Water Company, at the present time, is about 200,000 gallons. The available daily capacity of the filter is 500,000 gallons, and the rate of filtration 125,000,000 gallons per acre per 24 hours. The filter building, pure water well and pipes, are arranged for a future addition of three more filters of the same design and capacity, when the requirements of the service demand them.

The filter was run throughout the test under ordinary working conditions, and the filtered water was pumped directly into the mains and supplied to the consumers. It was in charge, under the writer's direction, of the regular pumping engineer of the East Providence Water Company. The writer gave directions from time to time, but did not, on the average, visit the filter plant more than once a week during the test.

The chemical analyses were made by Prof. John Howard Appleton of Brown University. The bacteriological work was done by Dr. Gardner T. Swarts, Secretary of the State Board of Health of Rhode Island, who also determined the color and alkalinity of the samples.

The chemical used during the test was sulphate of alumina. This was added to the raw water in the form of a coagulant solution, which was prepared by dissolving one part of sulphate of alumina in about 20 parts of filtered water. The solution was always thoroughly mixed before being used.

The test was commenced on March 10, 1899, and completed on August 2d. The chemical examinations were discontinued on May 25th, and the color and alkalinity analyses on May 31st.

The sulphate of alumina used during the test contained about 22 per cent of alumina, $Al_2 O_3$, with the exception of from March 10th to 11th inclusive, from June 1st to 7th inclusive, and from June 22d to 28th inclusive, when an inferior and cheaper grade containing about 17.53 per cent of alumina, Al_2O_3, was used.

The sulphate of alumina was added to the raw water during the test at the rate of 1 grain per gallon with the following exceptions, namely: from March 10th to 11th, from March 20th to 25th, and from May 1st to 6th, when 0.75 of a grain was used; from March 27th to 30th, when 0.60 of a grain was used; and from June 22d to 28th, when 1.25 grains were used.

The portions of the test during which quantities of sulphate of alumina other than that of 1 grain per gallon were used, and when the inferior grade of sulphate of alumina containing about 17.53 per cent of alumina, Al_2O_3, was used, were considered as special experiments.

The average removal of bacteria during the entire test, when the two grades of sulphate of alumina were used at different periods from 0.60 of a grain to 1.25 grains per gallon, was 98.7 per cent.

The average removal of bacteria during the time when 1 *grain of sulphate of alumina containing about* 22 *per cent of alumina,* $Al_2 O_3$*, was used, which was considered as the standard grade, was* 99.2 *per cent.*

Other average results obtained during the time that 1 grain of sulphate of alumina of the standard grade was used, show that there was:

6 per cent less Total Solids in the filtered water than there was in the raw water,
1 per cent less Chlorine in the filtered water,
61 per cent less Ferric oxide in the filtered water,
38 per cent less Aluminic oxide in the filtered water,
29 per cent less Free Ammonia in the filtered water.
63 per cent less Albuminoid Ammonia in the filtered water,
83 per cent less Color in the filtered water,
20 per cent increase of Hardness in the filtered water.

The filtered water in every instance was alkaline.

Attention is called to the fact that the preceding summary of results shows that the filtered water contained 38 per cent less alumina than did the raw water before the sulphate of alumina was added to it.

The results given in table No. 1 of Dr. Swarts' report, show that the average number of bacteria found in the filtered water during the time when 1 grain of sulphate of alumina of the standard grade was used, is less than 5 per cubic centimetre, which is a remarkably small number. Therefore, if the results given in the table should be used for comparison with results obtained with other filters, the small number of bacteria found in the filtered water should be duly taken into consideration, as well as the percentage of reduction.

EDMUND B. WESTON, C. E.

PROVIDENCE, R. I., Aug. 15, 1899.

(Inserted by the New York Filter Manufacturing Company.)

New York Filter Manufacturing Company, 26 Cortlandt Street, New York, N. Y.,

AND

O. H. Jewell Filter Company, 40-42 West Quincy Street, Chicago, Ill.

List of Municipal Filter Plants of the Jewell, Hyatt, Warren, American, National, Blessing and New York types, adopted by 140 City and Town Water Works. Total daily capacity—September, 1899—227,190,000 gallons. Twenty-seven of these cities and towns have increased their plants.

		Gallons.
Eufaula	Alabama,	500,000
*Gadsden	“	1,325,000
**Little Rock	Arkansas,	5,000,000
*Oakland	California,	5,000,000
Porterville	“	151,000
Riverside	“	86,000
*Greenwich	Connecticut,	2,000,000
*Atlanta	Georgia,	8,000,000
Athens	“	1,000,000
Augusta	“	6,000,000
La Grange	“	250,000
Eatonton	“	500,000
***Macon	“	3,500,000
Milledgeville	“	500,000
Rome	“	1,500,000
Alton	Illinois,	3,000,000
Cairo	“	800,000
Decatur	“	3,000,000
**Elgin	“	4,300,000
Lake Forest	“	1,000,000
Murphysboro	“	250,000
*Quincy	“	4,000,000
Rogers Park	“	400,000
**Terre Haute	Indiana,	4,000,000
Warsaw	“	500,000
*Waterloo	Iowa,	1,500,000
Burlington	“	3,500,000
Cedar Rapids	“	2,500,000
Davenport	“	7,500,000
Keokuk	“	3,000,000
Mt. Pleasant	“	500,000
Ottumwa	“	2,000,000
Dubuque	“	2,500,000
Caldwell	Kansas,	500,000
Council Grove	“	500,000
Kansas City	“	6,000,000
Oswego	“	500,000
Paola	“	250,000
Winfield	“	1,000,000
Danville	Kentucky,	500,000
Hopkinsville	“	500,000
Lexington	“	2,000,000
Winchester	“	750,000
Shreveport	Louisiana,	1,000,000
Bangor	Maine,	5,000,000
Biddeford	“	3,000,000
Calais	“	1,500,000
Mechanics Falls	“	720,000
North Berwick	“	300,000
Rumford Falls	“	500,000
Veazie	“	1,000,000
Athol	Massachusetts,	1,500,000
Reading	“	1,000,000
Catonsville	Maryland,	250,000
Mt. Clemens	Michigan,	1,000,000
Adrian	“	1,750,000
Brainerd	Minnesota,	500,000
Columbus	Mississippi,	1,000,000
*Holdon	Missouri,	200,000
Lamar	“	250,000
*Louisiana	“	802,000
*Rich Hill	“	200,000
Trenton	“	400,000
*St. Joseph	“	10,200,000
Nebraska City	Nebraska,	400,000
Exeter	New Hampshire,	114,000
Bordentown	New Jersey,	500,000
Keyport	“	500,000
Lakewood	“	500,000
*Long Branch	“	3,000,000
***Somerville	New Jersey,	2,000,000
Highstown	“	250,000
Attica	New York,	400,000
Elmira	“	6,000,000
Hornellsville	“	3,000,000
Kingston	“	4,000,000
Niagara Falls	“	4,500,000
*Owego	“	500,000
Richfield Springs	“	350,000
Valatie	“	150,000
*Asheville	North Carolina,	1,000,000
Charlotte	“	1,000,000
Durham	“	900,000
Goldsboro	“	500,000
Henderson	“	250,000
*Raleigh	“	1,000,000
*Salisbury	“	500,000
Winston	“	500,000
Bucyrus	Ohio,	500,000
Dennison	“	1,200,000
Lorain	“	3,000,000
Warren	“	1,500,000
Arnot	Pennsylvania,	120,000
Carlisle	“	1,500,000
Danville	“	1,000,000
Gettysburg	“	300.000
*Holmesburg	“	1,000,000
New Brighton	“	500,000
New Castle	“	4,000,000
Overbrook	“	250,000
Pickering Creek	“	750,000
Reading	“	250,000
Royersford	“	1,000,000
*Vandergrift	“	500,000
York	“	4,000,000
New Bethlehem	“	100.000
East Providence	Rhode Island,	500,000
Westerly	“	1,500,000
Columbia	South Carolina,	3,000,000
**Chattanooga	Tennessee,	9,000,000
Clarksville	“	1,500,000
*Knoxville	“	5,000,000
Greenville	Texas,	800,000
La Grange	“	250,000
Benwood	West Virginia,	1,000,000
Fairmont	“	1,000,000
Huntington	“	2,000,000
Morgantown	“	500,000
Norfolk	Virginia,	6,000.000
Merrill	Wisconsin,	1,000,000
*Oshkosh	“	2,400,000
Stevens Point	“	500,000
Bagota	U. S. Colombia,	1,000,000
Brandon	Manitoba,	1,000,000
Winnipeg	“	1,500,000
*Chatham	Ontario,	1,000,000
Deseronto	“	500,000
Dunville	“	500,000
Renfrew	“	432,000
*St. Thomas	“	2,000,000
Thurso	“	90,000
Fraserville	Quebec,	200,000
Longueuil	“	400,000
St. Hyacinthe	“	1,000,000
Chihuahua	Mexico,	1,000.000
Christiania	Norway,	300,000
Broken Hill	N. S. W., Australia,	1,600,000
Moscow	Russia,	750,000
Nijni-Novgorod	“	350 000
Tobolsk	Siberia,	200,000

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*These plants have been increased. The number of stars showing the number of times increased.